FORM PTO-1390 (Modified) (REV 5-93) U.S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 016915-0254

		U S APPLICATION NO. (If known, see 37 C.F.R. 1.5): Unassigned 10/009339
INTERNATIONAL APPLICATION NO. PCT/EP00/05211	INTERNATIONAL FILING DATE 06/07/2000	PRIORITY DATE CLAIMED 06/09/1999

TITLE OF INVENTION
DATA TRIP AND METHOD FOR CODING AND DECODING PRINTED DATA

APPLICANT(S) FOR DO/EO/US
Bernhard WIRNITZER, Andreas BRUGGER, Tilmann KRUEGER, and Detlev MEINERZ

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   - ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   - ☒ has been transmitted by the International Bureau.
   - ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   - ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   - ☐ have been transmitted by the International Bureau.
   - ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   - ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).
11. ☒ Applicant claims small entity status under 37 CFR 1.27 .

Items 12. to 17. below concern other document(s) or information included:

12. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
13. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
14. ☒ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ Other items or information: OTHER

JC07 Rec'd PCT/PTO 10 DEC 2001

U.S. APPLICATION NO (If known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
Unassigned 10/009339	PCT/EP00/05211	016915-0254

18. ☒ The following fees are submitted:	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5): Search Report has been prepared by the EPO or JPO.....$890.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482).....$710.00		
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2) $740.00		
Neither international preliminary examination fee (37 CFR 1.482) nor International search fee (37 CFR 1.445(a)(2)) paid to USPTO $1,040.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$890.00	
Surcharge of $130.00 for furnishing the oath or declaration later than 20 Months from the earliest claimed priority date (37 CFR 1.492(e))	$130.00	

Claims	Number Filed		Included in Basic Fee		Extra Claims		Rate		
Total Claims	17	-	20	=	0	×	$18.00	$0.00	
Independent Claims	2	-	3	=	0	×	$84.00	$0.00	
Multiple dependent claim(s) (if applicable)							$280.00		
TOTAL OF ABOVE CALCULATIONS =								$1020.00	
Reduction by ½ for filing by small entity, if applicable.								$510.00	
SUBTOTAL =								$510.00	
Processing fee of $130.00 for furnishing English translation later the 20 months from the earliest claimed priority date (37 CFR 1.492(f). +									
TOTAL NATIONAL FEE =								$510.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +									
TOTAL FEES ENCLOSED =								$510.00	

				Amount to be: refunded	$
				charged	$

a. ☒ A check in the amount of $510.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. 19-0741 in the amount of $0.00 to the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 19-0741. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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PATENT TRADEMARK OFFICE

SIGNATURE 34371

NAME Richard L. Schwaab

REGISTRATION NUMBER 25,479

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Attorney Docket No. 016915-0254

In re patent application of

Bernhard WIRNITZER et al.

Serial No.: Unassigned

Filed: December 10, 2001

For: DATA STRIP AND METHOD FOR CODING AND DECODING PRINTED DATA

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination of the above-identified application, Applicants respectfully request that the following amendments be entered into the application:

IN THE CLAIMS:

Please replace claims 3 through 7 and claims 10 through 17 as entered in the application during preliminary examination with the following amended claims:

--3. Data strip according to claim 1, **characterized in that** within the cell the printed area equals substantially the unprinted area.

4. Data strip according to claim 1, **characterized in that** the patterns are characterized by geometrical configuration and/or distribution of brightness.

5. Data strip according to claim 1, **characterized in that** more than two different patterns are used and that each pattern codes a sequence of information bits.

6. Data strip according to claim 1, **characterized in that** the stored information is overlaid by information, preferably visual information, which can be perceived by man.

7. Data strip according to claim 1, **characterized in that** for the overlay of the visual information the size of individual cells is varied accordingly.

10. Process according to claim 8, **characterized in that** the patterns are inverted.

11. Process according to claim 8, **characterized in that** within the cells printed and unprinted areas of about the same size are used.

12. Process according to claim 8, **characterized in that** the patterns are varied by geometrical configuration and/or distribution of brightness.

13. Process according to claim 8, **characterized in that** patterns having at least two different colors are brought about, being coded by exchanging the color.

14. Process according to claim 8, **characterized in that** the stored information is overlaid by information, in particular visual information, which can be perceived by man.

15. Process according to claim 8, **characterized in that** the size of the cells and/or the patterns is varied.

16. Process according to claim 8, **characterized in that** that the patterns used for coding are positioned on the support in predefined cells and/or predefined sequence.

17. Process according to claim 8 **characterized in that** by recording of parameters, predetermined sections of the support are not coded.--

REMARKS

Applicants respectfully request that the foregoing amendments to Claims 3 through 7 and Claims 10 though 17 be entered in order to avoid this application incurring a

for the presence of one or more multiple dependent claims. A marked-up version of the claims showing the changes made is attached.

Respectfully submitted,

December 10, 2001
Date

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VERSIONS WITH MARKINGS TO SHOW CHANGES MADE

3. Data strip according to [at least one of claims 1 to 2] claim 1, **characterized in that** within the cell the printed area equals substantially the unprinted area.

4. Data strip according to [at least one of claims 1 to 3] claim 1, **characterized in that** the patterns are characterized by geometrical configuration and/or distribution of brightness.

5. Data strip according to [at least one of claims 1 to 4] claim 1, **characterized in that** more than two different patterns are used and that each pattern codes a sequence of information bits.

6. Data strip according to [at least one of claims 1 to 5] claim 1, **characterized in that** the stored information is overlaid by information, preferably visual information, which can be perceived by man.

7. Data strip according to [at least one of claims 1 to 6] claim 1, **characterized in that** for the overlay of the visual information the size of individual cells is varied accordingly.

10. Process according to claim 8[or 9], **characterized in that** the patterns are inverted.

11. Process according to [at least one of claims 8 to 10] claim 8, **characterized in that** within the cells printed and unprinted areas of about the same size are used.

12. Process according to [at least one of claims 8 to 11] claim 8, **characterized in that** the patterns are varied by geometrical configuration and/or distribution of brightness.

13. Process according to [at least one of claims 8 to 12] claim 8, **characterized in that** patterns having at least two different colors are brought about, being coded by exchanging the color.

14. Process according to [at least one of claims 8 to 13] claim 8, **characterized in that** the stored information is overlaid by information, in particular visual information, which can be perceived by man.

15. Process according to [at least one of claims 8 to 14] claim 8, **characterized in that** the size of the cells and/or the patterns is varied.

16. Process according to [at least one of claims 8 to 15] claim 8, **characterized in that** that the patterns used for coding are positioned on the support in predefined cells and/or predefined sequence.

17. Process according to [at least one of claims 8 to 16] claim 8 **characterized in that** by recording of parameters, predetermined sections of the support are not coded.

Data Strip and Method for Coding and Decoding Printed Data

The invention relates to a data strip for storing printed coded data having a high data density as well as to a process for coding and decoding data on printed supports.

In order to store codes on products or objects, bar codes have been known for a long time and are widely used. For encoding information, bars of different widths are printed onto the object in varying spaced apart relationship. A reading device can capture the bar pattern and decode the information. The data density of such bar codes is as little as a few bits per square centimeter of the printing area. An example is US 3 211 470, wherein data reliability is increased by the provision of redundancy.

In order to attain higher data densities data codes are used, which are composed of a plurality of data lines. WO 86/05906 describes such a data strip. This data strip contains special synchronization regions serving to adjust the optical reading device to the data lines and to control the so-called scan rate at which the reading device captures line by line while being guided over the data strip. EP 0 670 555A1 provides synchronization zones in the form of margins of sections of the data strip. The firm Cobblestone Software Inc. describes a process at www.paperdisk.com having synchronous labels serving as a two-dimensional extension of bar codes. By this measure they aim at accommodating data densities of up to 4 megabytes on a sheet of 8 x 11 inches in the form of so-called data tiles.

It is a drawback of these known techniques that the data density attained is still too low for various applications. If it is desired, for example, to store in books or brochures sound samples of music or even speech on a data strip, then a sound sample of 10 seconds of speech or music of high quality corresponds to several hundred kilobytes of data. The size of the printed area required therefor is unacceptable.
If the data density in the known codes is increased in that the dots are progressively printed smaller, the printing process encounters limitations, e.g.

in that the dots merge. If the quality of the printing process fluctuates, the data strips are useless. At the same time, in the case of small printing points the demand on the image quality of the reading device increases. Typical and critical image errors are in this context distortion, astigmatism, coma and shadow images as they occur by reflections on parallel plates. Reading devices with simple optics can then no longer be employed. However, even high-quality image optics encounter physical limitations due to the theory of diffraction. The printing process and image optics give rise to the fact that the synchronization structures for the reading device appear blurred or distorted and that the synchronization onto the code fails despite expensive technology. The reason for this is that the aforementioned faults occur in unpredictable intensity and combination and that the faults further vary in location. In the event of high data densities, it is impossible to correct the particularly critical effect of distortion by co-ordination transformation as soon as individual printing points demerge or the printing points are depicted in a blurred manner.

In the event that image sensors are used in a code-reading device, such as, for example, CCD-line and CCD-surface sensors, a further problem arises. The aforementioned image sensors comprise two-dimensionally expanded sensor cells. If the sensor cells are not substantially smaller than the synchronization screen, the synchronization methods fail in this case as well.

The known methods require so-called overscanning by a factor 4 or even 6, as the synchronization screen is captured differently, depending on how the synchronization screen and the screen of the image sensor coincide. The disadvantages of small sensor cells are, however, the low light sensitivity, the high price of the sensors and the high data quantity during read-out.

US patent 4 782 221 further describes a printed data strip, wherein information is stored in many parallel, mutually adjoining data lines. The bits are stored by partially

printing on areas of defined and even size. A plurality of data lines are grouped together according to the invention into coded data zones, where the information is filed in sequence. In addition, vertical and horizontal synchronization headers are supplemented in order to adjust the optical reading device to the data lines.

This technique does not permit coding with a high data density such as is required for the present application. As described on page 4, lines 65-68, the so-called bit sections have a size of 0,25 mm x 0,15 to 0,9 x 0,43 mm. The data density attainable therewith is almost two orders of magnitude below the present application. The reason for this is the fact that the described synchronization headers fail in the event of smaller dimensions of the bit regions. In particular, cheap optical scanners lose synchronization within a data cell after as little as a few bit sections.

According to US 5 170 044 data bits are transferred in that in an array of preferably 3x3 cells some cells are printed while other cells are unprinted. By printing the so-called complementary array by exchanging the printed for the unprinted cells, coding of data bits is possible. A bit is thus coded in a plurality of cells (so-called pixels), permitting better error detection and error correction. Instead of individual data bits, complementary symbols are transferred. This technique, which has been known for decades in communication technology (see, e.g.: Shannon, C.E. Weaver, W.: The Mathematical Theory of Communication, University of Illinois Press, Urbana, 1949; Löffler, H.: Information-Signal-Nachrichtenverkehr *(Information-signal-communication traffic)*, Akademie-Verlag, Berlin 1990) is for the first time transferred to two-dimensional symbols. Decoding of the symbols is performed in that the symbols received are compared to the symbols transmitted and it is calculated in how many cells (pixels) the symbols differ. This very simple method is used, in order to derive the correct data bit in spite of incorrectly transmitted cells. Correction of errors by efficient techniques, such as, e.g. Hamming or BCH codes is dispensed with on the grounds that the calculation efforts of the necessary, non-linear equations would be

too high (column 2, lines 59-64). The fact that Hamming-codes form part of the linear block-codes, which can be decoded by very simple means by using shift registers (Hamming, W.R.: Information und Codierung *(Information and Coding)*. VCH-Verlag, Weinheim, 1986), is not considered in the patent.

The technique described in US 5 170 044 can likewise no longer be used for very small printing dots which, in the application described, are typically about 0,02 mm. Reasons for this are the fact that the printing dots extend differently on the paper and that, in particular, in the case of cheap scanner optics, an image is supplied where isolated dots are no longer recognizable. The image then shows heavily intersmudged printing dots. The simple decoding described in the patent then fails.

US 5 315 098 describes a technique for coding data in half tone images. This is done in that the orientation of non-rotation-symmetrical half-tone dots is rotated systematically. The size of the half-tone dots varies according to the local gray shading of the image. In US 5 706 099 this technique is improved to the effect that the impression of gray shading of the image perceived by the observer, is optimized. For this purpose the half-tone dots are replaced by half-tone cells, in the diagonally adjoining corners of which two 90-degree circular arcs are situated. For data coding the half-tone cells are turned by 90 degrees. Varying gray shadings are attained by circular arcs of varying thickness.

Decoding of the data bit consisting of such half-tone images presupposes, however, a very high-quality scanner, which must possess a very low geometrical distortion and high-quality optics with a high image definition. Decoding by means of a cheap hand scanner is inconceivable, since the appearing images of the individual half-tone cells vary considerably after the scanning process and are even different after each scanning process. Interferences depend, e.g., on the manufacturing accuracy of the scanner, image defects of the optics, the type of paper onto which the half-tone

image was printed and the relative tilting between scanner and data strip. Moreover, printing of the circular arcs is difficult by the digital printing technology, as circular arcs must be composed of rectangular half-tone dots.

A further drawback of the known codes is the susceptibility to dirt accumulations, wear and tear or deformations of the data carrier. In addition, the coarse data and synchronization structures are perceptible to the human eye and may be a source of problems in various applications. Moreover, the codes offer no possibility for the simultaneous transmission of visual information, such as, e.g. company logos or pictures.

It was, therefore, an object of the invention to provide a code for printed data as well as a method for coding and decoding these printed data permitting a high data density while offering simultaneously a high degree of reliability of the code, in which context additional, in particular visual information, may be overlaying the code, ensuring reliable coding and decoding of these printed data.

This object is attained according to the invention by a data strip for storing printed coded data having a high data density, the printed area of the data strip being divided into cells and one of at least two different patterns having a characteristic, predefined form being respectively printed in a two dimensional cell having a predefined form and by a process for coding and decoding data on printed supports, the coding being performed in the form of two-dimensional cells and the cells being positioned at defined locations on the support, which in each case comprise at least two different patterns having a characteristic and predefined form, the inner structure of the cells being utilized for decoding.

The patterns according to the invention having a characteristic and predefined form may be so fine that the human eye, due to local resolution being too low, sees them

as homogeneous dots. The typical dimension of such a pattern is approximately 0,02 mm, subject to the printing technique. According to the invention other transfer processes may, in principle, also be used, such as, for example, die stamping or die cutting techniques, in which context the supports to be printed on in these cases consist preferably of solid materials, such as plastics or metal.

The patterns are within defined, two-dimensional cells, which are repeated in a predefined manner in the horizontal and vertical directions. A pattern advantageously fills out 50% of a cell, whereby in the cell the printed area equals substantially the unprinted area thus causing the two-dimensional data strip to appear to the eye as a homogeneously colored area.

For storing a data bit, the printed area in the patterns is preferably exchanged for the unprinted area, particularly advantageously a pattern is replaced or not by its negative image.

For example, a black cross on a white background turns into a white cross on a black background. The eye still perceives the area in a homogeneous color.

The patterns themselves are so designed that after image capturing by the reading device they are readily perceptible and well distinguishable. The patterns may be characterized both by their geometrical shape and by the distribution of brightness.

In particular, sets of orthogonal patterns, e.g. a pattern and the associated negative image are in this context well suited.

The use of colored patterns in combination with a color reading device permits in this context particularly high data densities. In a pattern with areas having the basic colors red, green and blue, three orthogonal patterns come about by exchanging the colors. To the eye the cell appears in a homogeneous color, irrespective of the respective pattern.

By using a plurality of different patterns, a plurality of bits or bit sequences may be stored in a two-dimensional cell.

Distortions, coming about by the printing process or by image properties of the optics, may already be taken into account when selecting the patterns. The patterns are designed according to known processes in such a manner that they can be transferred as well as possible and are well distinguishable after transfer.
Thus, the problem of merging of printing points by printing smaller dots can be avoided.

With the data strip according to the invention and the process according to the invention the effects of astigmatism or coma can likewise be suppressed.

In known transfer properties of the print and reading device an optimal arrangement of the patterns is thus possible with the aid of the system theory. It must be taken into consideration in this context that the spatial frequency of the patterns after image recording should, if possible, not coincide with the spatial frequencies of accidental noise.

Systematic interferences during printing and in the reading device are, on the other hand, not critical, such as, for example, the occurrence of a shadow image, since the function of the decoder is not affected. It is even possible for the images of the patterns to overlap.

Coding of the data is performed in accordance with the invention in the form of two-dimensional cells, in which context the cells are positioned at defined locations on the support, containing in each case one of at least two different patterns having a characteristic, predefined form. During decoding, the defined patterns are searched for by methods of pattern recognition and after recognition are applied to the underlying bit information.

For pattern recognition correlations with determined search patterns are in the process carried out advantageously in order to look for the images of the characteristic two-dimensional patterns on the strip with the input data.

The number of correlators corresponds substantially to the number of the defined patterns If the brightness of the image of a pattern is described by the function m(x,y) and the brightness of the image of the data memorized on the data tape by d(x,y), then the correlator calculates the integral kor(x,y) = INTEGRAL {d(d',y') m(x'+x,y'+y)} dx' dy'. By comparing the correlation integrals, the underlying search pattern can be derived. The correlation integral kor(x,y) indicates an extreme value at those locations where the cell was repeated in a predefined manner.

Instead of the correlation integral other methods of pattern recognition may also be employed.

Advantageously, the data are entered for decoding by a device the spatial resolution of which is above the highest spatial frequency of the data strip by at least a factor 2.

Preferably, the patterns used for coding are positioned on the support in predefined cells and/or predefined sequence so that deviations from the pattern structure caused by distortions in the event of bad quality print, poor image quality of the optics of the reading device and/or tilting of the data strip, may be recognized. As a result, it is possible to establish how the patterns are transferred realistically and to control in this manner linear and non-linear transfer properties of the data transfer channel. This permits, in the aforementioned cases as well, decoding which is largely reliable.

Further increased decoding reliability is attained in that the location of the maximum of the correlation function is compared to the defined positions of the cells. In this manner it can be determined which geometrical transformations took place during printing and during the reading process. Examples for this are distortion, tilting and size variations. The search patterns may thus be adapted accordingly to the transformation.

The patterns positioned in predefined cells and/or predefined sequence on the support are used particularly advantageously as search patterns for pattern recognition, so that greater deviations from the desired structure may be compensated for as well.

With the code according to the invention in conjunction with the process according to the invention decoding is, in principle, possible in the event of any distortions as long as the patterns remain recognizable.

Since the patterns are situated at defined locations in a cell, a further advantage of the solution according to the invention results from the fact that it is possible to measure the local distortion or tilting by determining during

pattern recognition the location where the pattern is situated and by comparing it to the defined desired position.

With this information the search patterns are adapted, e.g. turned or changed in size. By means of a parameterized, mathematical model of distortion and tilting, the parameters of this model may be estimated by way of a Kalman-filter. As a result, detection becomes even more immune to noise.

The adaptation according to the invention of the patterns during pattern recognition permits distinctly increased decoding reliability at a simultaneously increased data density.

Experiments have shown that, by means of the patterns according of the invention and the method according to the invention, a completely unexpected increase in the data density is made possible. Data densities of over 10 kilobytes per square centimeter of printing area could be attained. As a result, it is possible, for example, to store up to 20 minutes of music by printing on the inside and the outside of a CD cover after the music data were compressed by way of conventional procedures.

Decoding of data bits becomes surprisingly reliable and safe by the coding according to the invention in combination with modern image processing, despite the high data density. It has been shown that especially in the case of small cell sizes and in the case of patterns having a fine structure, which can no longer be resolved by the human eye, particularly reliable decoding is possible.

In contrast to known codes, a wavy support or unevenness in the movement of the reading device are not critical. Dirt accumulations in the optics may likewise be compensated for.

The data strip according to the invention has the advantage that, in principle, it can manage without synchronization regions.

As synchronization in the conventional sense is dispensed with, high overscanning by a factor 2 to 6, required for synchronization during decoding, is likewise dispensed with.

Pattern recognition searches for the most probable pattern in a cell and derives therefrom the underlying information bits. For pattern recognition, overscanning is, in principle, not necessary. However, overscanning by a factor of 1,5 to 2 has proved to be advantageous.

As overscanning is performed in the horizontal and vertical directions, the amount of data to be processed in the reading device, in comparison with known methods, drops by more than a factor of 7.

The method according to the invention permits largely reliable decoding, even in the event that the printed patterns, e.g. due to a poor image, intermingle substantially. Since each of the defined patterns *per se* influences the neighboring cells in the same manner, it is possible, after a pattern has been recognized once, to take into account the influence on the neighboring cells in a decision feedback during pattern recognition.

According to the invention, additional, in particular visual information may be overlaid on the coded data without the data density being reduced.

This may be done in that the cell or even the pattern in the cell are changed in size. As a result, the cell appears lighter or darker to the observer. From a printing-technical point of view, size variations of up to 50% of the characteristic pattern or cell are possible without any problems.

Particularly advantageous, however, is the overlay of image information by changing the printing ink. This may be done in such a manner that it remains largely unnoticeable to the reading device. If, e.g., an optical reading device with a red filter is used, green, yellow or black printing ink appear likewise at a low image intensity. The brightness of the patterns may likewise be varied for overlaying visual information.

Experiments show that fluctuations in the image intensity are acceptable up to 50%.

In the data strip according to the invention it is possible for overlaying visual information to also leave data-free sections. This is, for example, possible if full-surface image structures, such as, for example, black eyes in depicted faces or the like are overlaid on the coded data and, due to large, very dark areas, coding is not possible. In this case, it is preferred to code markers in defined cells, defining the limits of data-free sections on the data strip.

The invention is explained in what follows by way of drawings and working examples. There are shown in:

Fig. 1 the possibility to code an individual data bit,
Fig. 2 the periodic repetition of the cells which cannot be resolved by the eye,
Fig. 3 the bringing about of a defined line shift in the case of periodic repetition of the cells which cannot be resolved by eye,
Fig. 4 the possibility for coding a 3 bit sequence and
Fig. 5 the process steps for decoding the code.

Fig. 1 illustrates, by way of example, a possibility to code simultaneously a logic ZERO or ONE and pictorial information. The printing patterns 1 or 3 represent in this case a logic zero, the printing patterns 2 or 4 represent a logic ONE. The patterns are printed so small that they cannot be resolved by the eye and appear merely as a gray dot. The reading device can, however, recognize the shape of the patterns. Overlaying of pictorial-like information is brought about in that the color or brightness in the printing pattern 1" or 2" is changed. In the printing pattern 1' or 2' the characteristic pattern is reduced in order to create a lesser impression of brightness for the eye.

Fig. 2 shows how the pattern pair 1 and 2 in defined spaced apart relationship is periodically repeated in two directions 5 and 6, thus forming the two-dimensional data strip.

In Fig. 3 the pattern pair 1 and 2 is periodically repeated in diagonal direction 7. Each second line, structured by patterns, appears, therefore, off-set. This facilitates pattern recognition in the reading device.

The use illustrated in Fig. 4 of four complex patterns 8, 9, 10 and 11 permits, together with the inverted-inverted patterns 8', 9', 10' and 11', coding of a 3 bit sequence, as shown in fields 8", 9", 10' and 11". Other typical, two-dimensional patterns may, of course, also be used. The decisive factor in the process is that the patterns differ clearly so as to be readily recognizable by the reading device.

A comparison of Fig. 4 with Fig. 5 shows: Each pattern in Fig. 2 codes one bit in a 2x2 printing cell. Each pattern in Fig. 4 codes 3 bits in a 2x3 printing cell, the data density thus being twice as large. In the case of the decoding of the data strip according to Fig. 5, the code having the higher data density surprisingly shows a lesser bit error rate – the patterns are recognized better.

The principal function of a corresponding reading device is shown in Fig. 5 in a block diagram. The image recorded by the reading device of the data strip 15 first enters a processing block 12, performing pattern recognition. This may be performed, e.g., by a correlation of the image data 15 with the printed patterns. The correlator is in this context so designed that it remains unaffected by fluctuations in brightness or colors of the pattern, permitting an overlay of the data strip with graphics or images. Should the data strip contain different patterns, correlation with different patterns is then performed. Other methods of pattern recognition can also be used. After the pattern has been recognized, the coded bit in block 16 or the coded bit sequence are

derived and the bits are issued 14. Block 13 determines the location where the pattern was recognized, comparing it with the predefined location 17 where the pattern was expected. If both locations differ from one another, the image of the data strip is shifted, turned or distorted. In block 12 for pattern recognition the search patterns are then adapted accordingly and pattern recognition is performed again. In addition, the locations, where the patterns are expected, are newly determined. These new pattern locations 18 are used in the next processing cycle as defined pattern locations 18.

NEW PATENT CLAIMS

1. Data strip for storing printed, coded data having a high data density, the printed area of the data strip being divided into cells and one of at least two different patterns having a characteristic, predefined shape being respectively printed in a two-dimensional cell having a predefined shape, **characterized in that** the patterns are of such dimensions that they cannot be resolved by the human eye and that the said data strip comprises search patterns at defined locations for comparison with the information-carrying patterns used.

2. Data strip according to claim 1, **characterized in that** the patterns differ from one another in that the printed area is exchanged for the unprinted area.

3. Data strip according to at least one of claims 1 to 2, **characterized in that** within the cell the printed area equals substantially the unprinted area.

4. Data strip according to at least one of claims 1 to 3, **characterized in that** the patterns are characterized by geometrical configuration and/or distribution of brightness.

5. Data strip according to at least one of claims 1 to 4, **characterized in that** more than two different patterns are used and that each pattern codes a sequence of information bits.

6. Data strip according to at least one of claims 1 to 5, **characterized in that** the stored information is overlaid by information, preferably visual information, which can be perceived by man.

7. Data strip according to at least one of claims 1 to 6, **characterized in that** for the overlay of the visual information the size of individual cells is varied accordingly.

8. Process for decoding data on printed supports, the coding being performed in the form of two-dimensional cells, the cells being positioned on the support at defined locations, the cells for storing data containing in each case at least two different patterns and some defined cells storing no data, but containing in a defined manner one each of the different patterns as a search pattern, **characterized in that** the two-dimensional search patterns are captured by a device and the recorded signals are used for the recognition of the information-carrying patterns.

9. Process according to claim 8, **characterized in that** the position, rotation and appearance of the recognized, information-carrying patterns are compared to the defined position, rotation and form of appearance, in order to adjust position, rotation and form of appearance of the search patterns.

10. Process according to claim 8 or 9, **characterized in that** the patterns are inverted.

11. Process according to at least one of claims 8 to 10, **characterized in that** within the cells printed and unprinted areas of about the same size are used.

12. Process according to at least one of claims 8 to 11, **characterized in that** the patterns are varied by geometrical configuration and/or distribution of brightness.

13. Process according to at least one of claims 8 to 12, **characterized in that** patterns having at least two different colors are brought about, being coded by exchanging the color.

14. Process according to at least one of claims 8 to 13, **characterized in that** the stored information is overlaid by information, in particular visual information, which can be perceived by man.

15. Process according to at least one of claims 8 to 14, **characterized in that** the size of the cells and/or the patterns is varied.

16. Process according to at least one of claims 8 to 15, **characterized in that** that the patterns used for coding are positioned on the support in predefined cells and/or predefined sequence.

17. Process according to at least one of claims 8 to 16 **characterized in that** by recording of parameters, predetermined sections of the support are not coded.

Title: DATA STRIP AND METHOD
FOR CODING AND DECODING
PRINTED DATA
Inventor(s): Bernhard WIRNITZER et al.
DOCKET NO.: 016915-0254

10/009339

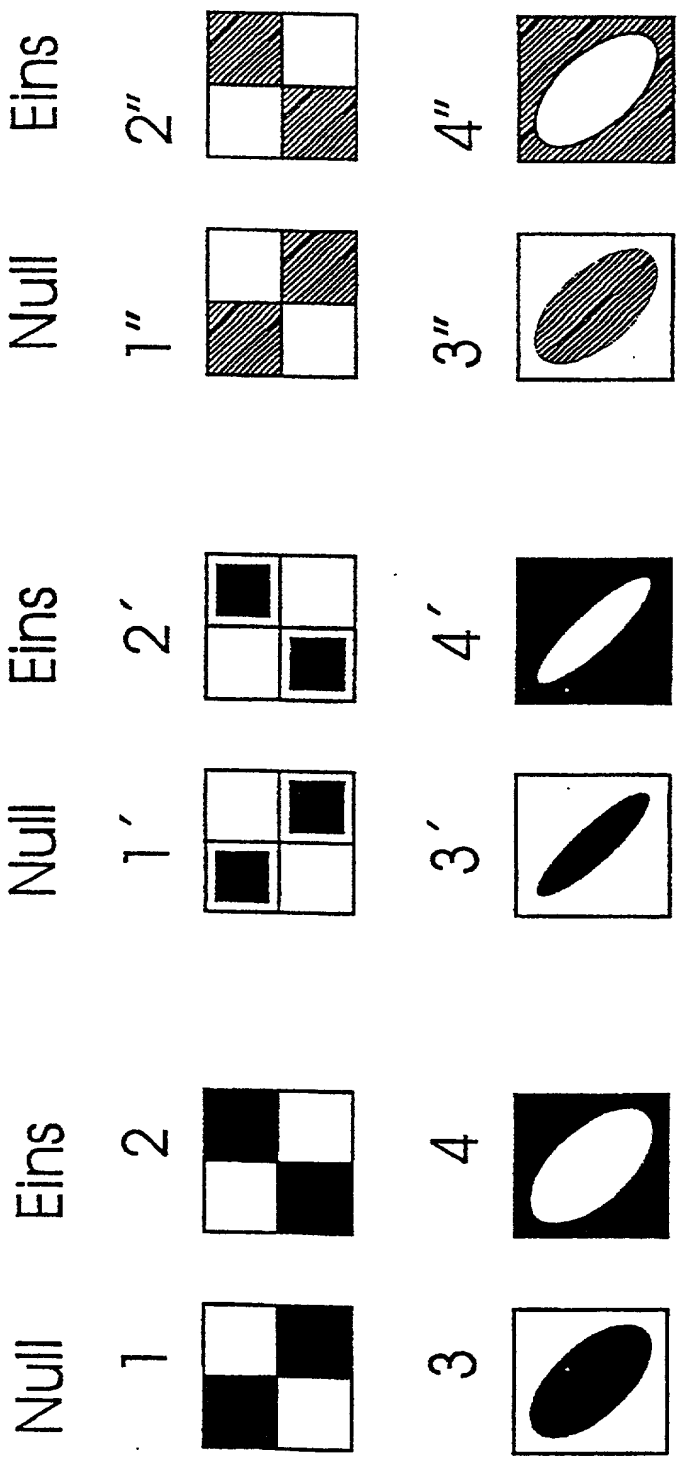

Fig. 1

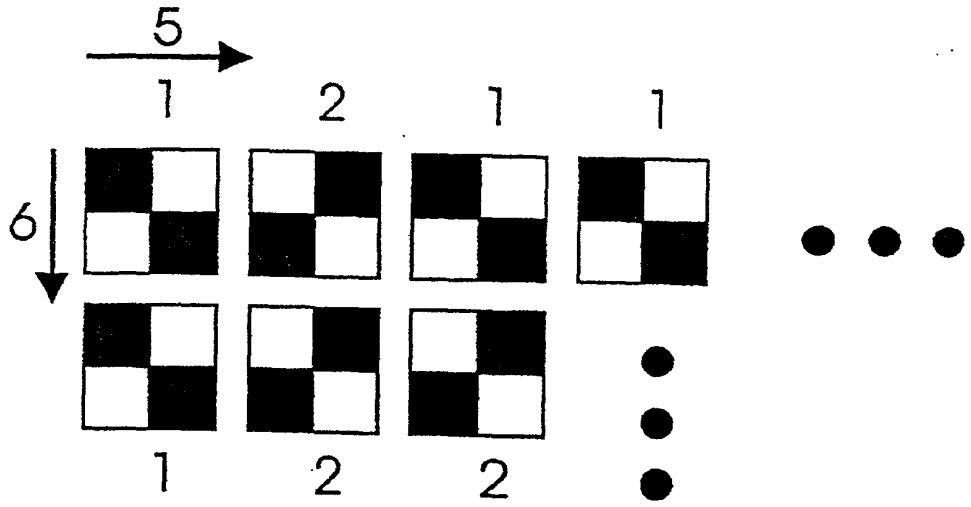

Fig. 2

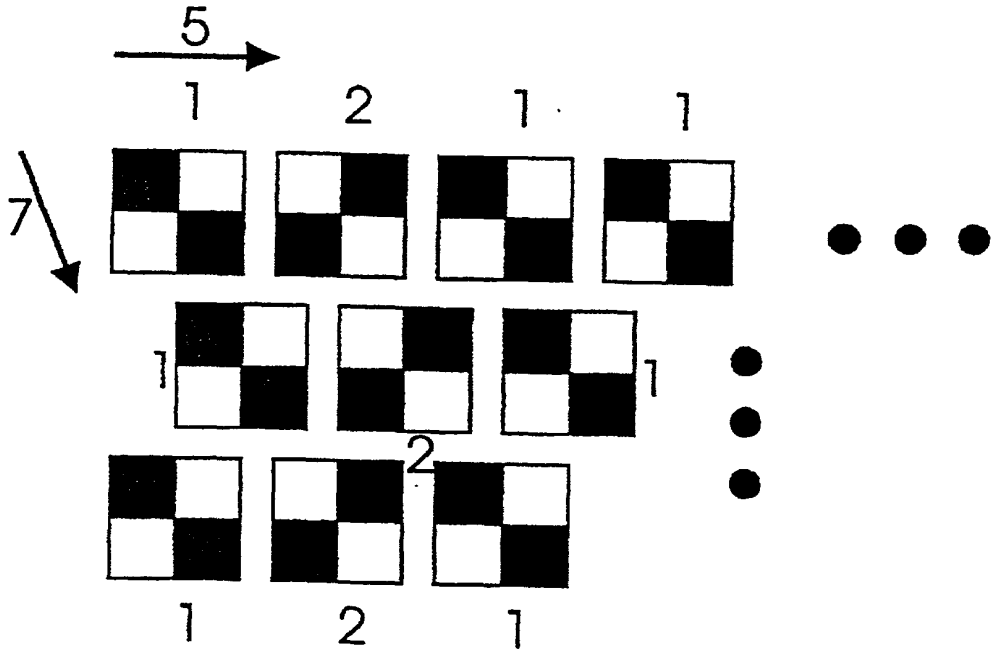

Fig. 3

Title: DATA STRIP AND METHOD
FOR CODING AND DECODING
PRINTED DATA
Inventor(s): Bernhard WIRNITZER et al.
DOCKET NO.: 016915-0254
10/009339

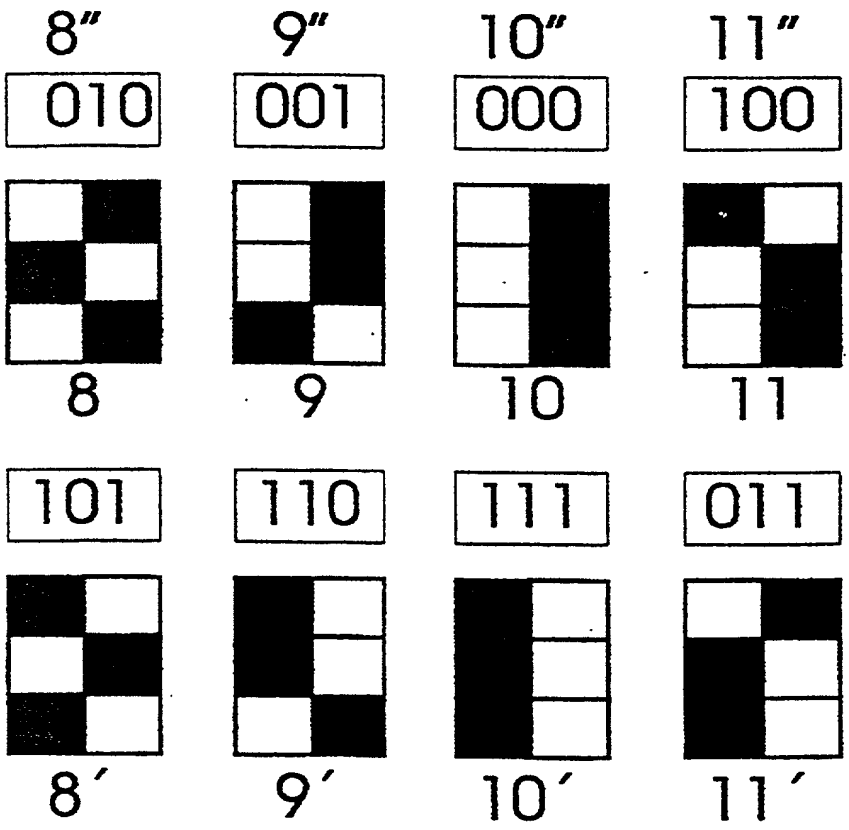

Fig. 4

Title: DATA STRIP AND METHOD
FOR CODING AND DECODING
PRINTED DATA
Inventor(s): Bernhard WIRNITZER et al.
DOCKET NO.: 016915-0254
10/009339

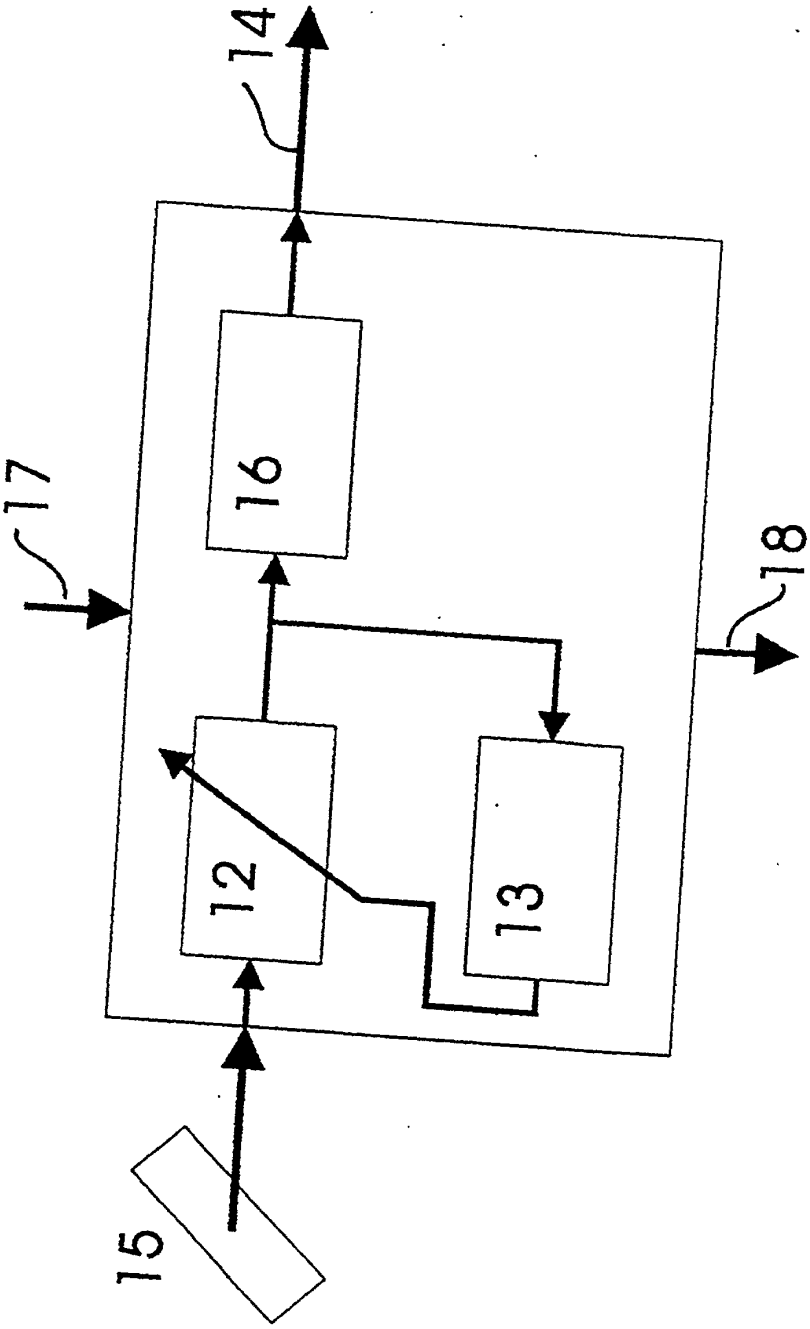

Fig. 5

dsw 4930 PCTUS

Atty. Dkt. No. 016915-0254

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I HEREBY DECLARE:

THAT my residence, post office address, and citizenship are as stated below next to my name;

THAT I believe I am the original, first, and sole inventor (if only one inventor is named below) or an original, first, and joint inventor (if plural inventors are named below or in an attached Declaration) of the subject matter which is claimed and for which a patent is sought on the invention entitled

DATA STRIP AND METHOD FOR CODING AND DECODING PRINTED DATA

(Attorney Docket No. 016915-0254)

the specification of which (check one)

____ is attached hereto.

_X_ was filed on June 7, 2000 as United States Application Number or PCT International Application Number PCT/EP00/05211 and was amended on October 12, 2000, and December 10, 2001 (if applicable).

THAT I do not know and do not believe that the same invention was ever known or used by others in the United States of America, or was patented or described in any printed publication in any country, before I (we) invented it;

THAT I do not know and do not believe that the same invention was patented or described in any printed publication in any country, or in public use or on sale in the United States of America, for more than one year prior to the filing date of this United States application;

THAT I do not know and do not believe that the same invention was first patented or made the subject of an inventor's certificate that issued in any country foreign to the United States of America before the filing date of this United States application if the foreign application was filed by me (us), or by my (our) legal representatives or assigns, more than twelve months (six months for design patents) prior to the filing date of this United States application;

THAT I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment specifically referred to above;

THAT I believe that the above-identified specification contains a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the invention, and sets forth the best mode contemplated by me of carrying out the invention; and

THAT I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I HEREBY CLAIM foreign priority benefits under Title 35, United States Code §119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below any foreign application for patent or inventor's certificate or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number	Country	Foreign Filing Date	Priority Claimed?	Certified Copy Attached?
199 26 194.6	Federal Republic of Germany	June 9, 1999	YES	

I HEREBY CLAIM the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below.

U.S. Provisional Application Number	Filing Date

I HEREBY CLAIM the benefit under Title 35, United States Code, §120 of any United States application(s), or § 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application Number	PCT Parent Application Number	Parent Filing Date	Parent Patent Number

I HEREBY APPOINT the following registered attorneys and agents of the law firm of FOLEY & LARDNER:

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to have full power to prosecute this application and any continuations, divisions, reissues, and reexaminations thereof, to receive the patent, and to transact all business in the United States Patent and Trademark Office connected therewith.

I request that all correspondence be directed to:

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I UNDERSTAND AND AGREE THAT the foregoing attorneys and agents appointed by me to prosecute this application do not personally represent me or my legal interests, but instead represent the interests of the legal owner(s) of the invention described in this application.

I FURTHER DECLARE THAT all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

1-00

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Date	20-2-02

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3-02

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Inventor's signature	
Date	January 28, 2002

Applicant or Patentee: Bernhard WIRNITZER et al.
Serial or Patent No.: Unassigned Atty. Dkt. No. 016915-0254
Filed or Issued: December 10, 2001
For: DATA STRIP AND METHOD FOR CODING AND DECODING PRINTED DATA

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS
(37 CFR 1.27) — SMALL BUSINESS CONCERN

I hereby declare that I am

( ) the owner of the small business concern identified below:
(X) an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN: DATASOUND GESELLSCHAFT ZUR ENTWICKLUNG UND VERMARKTUNG DIGITALER AUDIO- UND INFORMATIONSSYSTEME, GmbH

ADDRESS OF CONCERN: Rheinuferstrasse 9
D-67061 Ludwigshafen, Federal Republic of Germany

I hereby declare that the above-identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18 and reproduced in 37 CFR 1.27, for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled DATA STRIP AND METHOD FOR CODING AND DECODING PRINTED DATA TAPES by inventors Bernhard WIRNITZER et al., described in

( ) the specification filed herewith
(X) application serial no. PCT/EP00/05211, filed June 7, 2000
( ) patent no._____ , issued _____

If the rights held by the above-identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below* and no rights to the invention are held by any person, other than the inventor, who would not qualify as an independent inventor under 37 CFR 1.27(a)(1) if that person made the invention, or by any concern which would not qualify as a small business concern under 37 CFR 1.27(a)(2) or a nonprofit organization under 37 CFR 1.27(a)(3). * NOTE: Separate

verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities: (37 CFR 1.27)

NAME: _____
ADDRESS: _____
( ) INDIVIDUAL( ) SMALL BUSINESS CONCERN( ) NONPROFIT CORPORATION

NAME: _____
ADDRESS: _____
( ) INDIVIDUAL( ) SMALL BUSINESS CONCERN( ) NONPROFIT CORPORATION

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate: (37 CFR 1.27.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING: Johannes Hamann
TITLE OF PERSON OTHER THAN OWNER: Managing Director
ADDRESS OF PERSON SIGNING: Tannhäuserring 178, 68199 Mannheim
SIGNATURE: _____ DATE: 27.09.02

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